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(30) Priority Data:
60/372,632 15 April 2002 (15.04.2002) US

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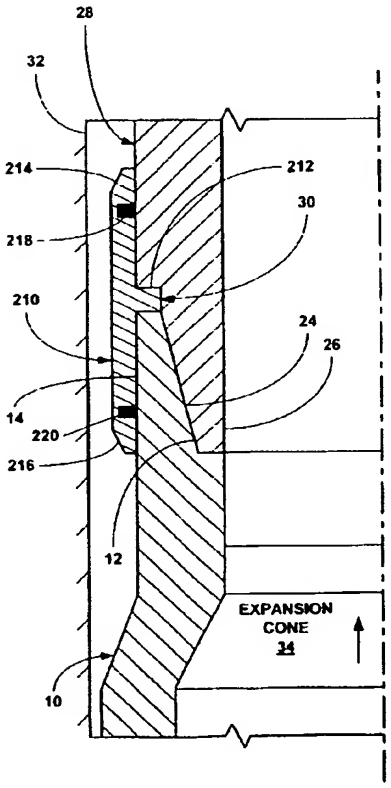
(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH,

[Continued on next page]

(54) Title: PROTECTIVE SLEEVE FOR THREADED CONNECTIONS FOR EXPANDABLE LINER HANGER



(57) Abstract: A tubular sleeve (210) is coupled to and overlaps the threaded connection (12, 14) between a pair of adjacent tubular members (14, 16).

GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

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Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *with international search report*

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26 February 2004

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/10144

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : E21B 19/16
US CL : 166/380, 85.3, 309, 387, 72, 73,; 285/382.7, 398
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 166/380, 85.3, 309, 387, 72, 73, 187, 195, 206, 207, 212, 216, 217; 285/382.7, 398, 55, 388.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6,405,761A (SHIMIZU et al) 18 June 2002, see entire document	1-144
A	US 5,971,443 A (NOEL et al) 26 October 1999, see entire document	1-144
A	US 5,309,621 A (O'DONNELL et al)10 May 1994, see entire document	1-144
A	US 3,997,193 A (TSUDA et al) 14 December 1976, see entire document	1-144
A	US 3,989,280 A (SCHWARZ) 02 November 1976, see entire document	1-144
A	US3,834,742 A (MCPHILLIPS) 10 September 1974, see entire document	1-144
A	US 3,579,805 A (KAST) 25 May 1971, see entire document	1-144
A	US 2,647,847 A (BLACK et al) 04 August 1953, see entire document	1-144
X	US 4,693,498 A (BAUGH et al) 15 September 1987, see Fig. 2a and 2b	64

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2003 (30.07.2003)	31 OCT 2003
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer Roger J. Schoeppel Telephone No. (703) 306-4180

Form PCT/ISA/210 (second sheet) (July 1998)

PCT/US03/10144

INTERNATIONAL SEARCH REPORT

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,275,556 A (KINNEY et al) 14 August 2001, see Fig. 3	64

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/10144

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

PCT/US03/10144

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

The inventions listed as Groups I-IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: Group I comprises the method of radially deforming a tubular with plastic deformation whereas Group II does not make such a deformation. Groups III and IV comprise using a tubular subjected to radial deforming and plastic deformation (in eight of the independent claims) in completing a geothermal energy well. The groups are further distinguished in whether a flanged sleeve is used in making up a tubular string, whether the flange is internal or external, whether the connecting tubes are threaded or not, inter alia such as whether or not seals are used in the connection.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

I. Claims 1-63, comprising 5 independent claims, drawn to a "Method".
II. Claims 64-127, comprising 5 independent claims, drawn to an "Apparatus".
III. Claims 124-141, comprising 10 independent claims, drawn to a "Method and Apparatus for Extracting Geothermal Energy."
IV. Claim 142, drawn to a "Method of Testing."

101.02

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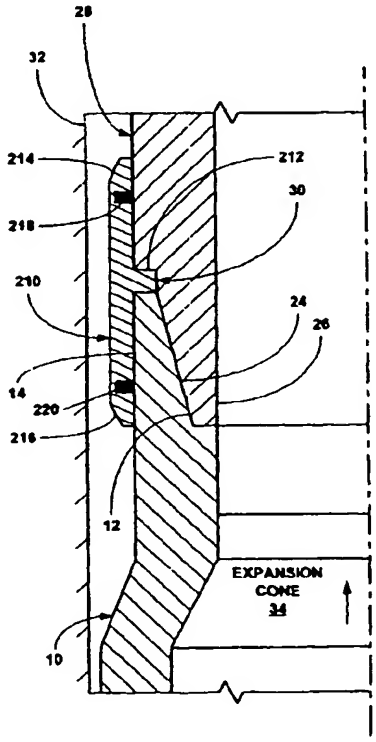

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AMENDED CLAIMS

[received by the International Bureau on 17 December, 2003 (17-12-03);
original claims 65-67, 76, 85, 86, 88, 92, 94, 95, 97, 101, 103, 104, 108-118 and 120 amended;
original claim 64 cancelled;
remaining claims unchanged (18 pages)]

tubular sleeve;

inserting an end of a first tubular member into an end of the tubular sleeve into abutment with the internal flange;

inserting an end of a second tubular member into another end of the tubular sleeve into abutment the internal flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members;

placing the tubular sleeve in circumferential tension;

placing the end of the first tubular member in circumferential compression; and

placing the end of the second tubular member in circumferential compression.

63. A method, comprising:

providing a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

inserting an end of the tubular sleeve into an end of a first tubular member until the end of the first tubular member abuts with the external flange;

inserting another end of the tubular sleeve into an end of the second tubular member until the end of the second tubular member abuts the external flange;

threadably coupling the ends of the first and second tubular members;

radially expanding and plastically deforming only the portions of the first tubular member and the second tubular member proximate the threads of the first and second tubular members;

placing the tubular sleeve in circumferential compression;

placing the end of the first tubular member in circumferential tension; and

placing the end of the second tubular member in circumferential tension.

64. (Cancelled)

65. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein the tubular sleeve is in circumferential tension;

AMENDED SHEET (ARTICLE 19)

abut the internal flange of the tubular sleeve.

74. The apparatus of claim 67, wherein the internal flange of the tubular sleeve is positioned between the ends of the tubular sleeve.

75. The apparatus of claim 67, wherein the internal flange of the tubular sleeve is positioned at an end of the tubular sleeve.

76. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein the tubular sleeve comprises an external flange.

77. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the first tubular member; and wherein another end portion of the tubular sleeve is received within the end portion of the second tubular member.

78. The apparatus of claim 77, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

79. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the end portion of the first tubular member.

80. The apparatus of claim 79, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

81. The apparatus of claim 76, wherein an end portion of the tubular sleeve is received within the end portion of the second tubular member.

82. The apparatus of claim 81, wherein the end portions of the first and second tubular members abut the external flange of the tubular sleeve.

83. The apparatus of claim 76, wherein the external flange of the tubular sleeve is positioned between the ends of the tubular sleeve.

91. The apparatus of claim 88, wherein the retaining ring is resilient.

92. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein the end of the tubular sleeve is deformed onto the end of the first tubular member.

93. The apparatus of claim 92, wherein the other end of the tubular sleeve is deformed onto the end of the second tubular member.

94. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein the other end of the tubular sleeve is deformed onto the end of the second tubular member.

95. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve;

a second tubular member coupled to another end of the tubular sleeve and the first tubular member; and

a retaining ring coupled to the end of the first tubular member for retaining the tubular sleeve onto the end of the first tubular member.

96. The apparatus of claim 95, further comprising:

another retaining ring coupled to the end of the second tubular member for retaining the other end of the tubular sleeve onto the end of the second tubular member.

97. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve;

a second tubular member coupled to another end of the tubular sleeve and the first tubular

105. The apparatus of claim 104, wherein the tubular sleeve further comprises:
a sealing member for fluidicly sealing the interface between the tubular sleeve and the structure.

106. The apparatus of claim 104, wherein the other structure comprises a wellbore.

107. The apparatus of claim 104, wherein the other structure comprises a wellbore casing.

108. An apparatus, comprising:
a tubular sleeve;
a first tubular member coupled to an end of the tubular sleeve; and
a second tubular member coupled to another end of the tubular sleeve and the first tubular member;
wherein the tubular sleeve further comprises a sealing element coupled to the exterior surface of the tubular sleeve.

109. An apparatus, comprising:
a tubular sleeve;
a first tubular member coupled to an end of the tubular sleeve; and
a second tubular member coupled to another end of the tubular sleeve and the first tubular member;
wherein the tubular sleeve is metallic.

110. An apparatus, comprising:
a tubular sleeve;
a first tubular member coupled to an end of the tubular sleeve; and
a second tubular member coupled to another end of the tubular sleeve and the first tubular member;
wherein the tubular sleeve is non-metallic.

111. An apparatus, comprising:
a tubular sleeve;
a first tubular member coupled to an end of the tubular sleeve; and
a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein the first and second tubular members are amorphously bonded.

117. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein the first and second tubular members are welded.

118. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein only the portions of the first and second tubular members proximate the tubular sleeve are plastically deformed.

119. The apparatus of claim 118, wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members.

120. An apparatus, comprising:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve; and

a second tubular member coupled to another end of the tubular sleeve and the first tubular member;

wherein the first tubular member comprises internal threads; and

wherein the second tubular member comprises external threads that engage the internal threads of the first tubular member.

121. The apparatus of claim 120, wherein only the portions of the first and second members proximate the threads of the first and second tubular members are plastically deformed.

122. The apparatus of claim 121, wherein a fluid tight seal is provided between the threads of the first and second tubular members.

123. The apparatus of claim 121, wherein a fluid tight seal is provided between the tubular sleeve

wherein the end of the second tubular member is in circumferential compression;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

127. An apparatus, comprising:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve and abuts the external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

128. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;

radially expanding and plastically deforming the first casing string within the borehole;

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings.

129. The method of claim 128, wherein the interior diameter of a passage defined by the first and second casing strings is constant.

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads; and

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member.

133. A method of extracting geothermal energy from a subterranean source of geothermal energy, comprising:

drilling a borehole that traverses the subterranean source of geothermal energy;

positioning a first casing string within the borehole;

radially expanding and plastically deforming the first casing string within the borehole;

positioning a second casing string within the borehole that traverses the subterranean source of geothermal energy;

overlapping a portion of the second casing string with a portion of the first casing string;

radially expanding and plastically deforming the second casing string within the borehole; and

extracting geothermal energy from the subterranean source of geothermal energy using the first and second casing strings;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads; and

a second tubular member received within another end of the tubular sleeve in

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

135. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing positioned within the borehole that overlaps with the first casing string that traverses the subterranean source of geothermal energy;

wherein the first casing string and the second casing string are radially expanded and plastically deformed within the borehole.

136. The apparatus of claim 135, wherein the interior diameter of a passage defined by the first and second casing strings is constant.

137. The apparatus of claim 135, wherein at least one of the first and second casing strings comprise:

a tubular sleeve;

a first tubular member coupled to an end of the tubular sleeve comprising internal threads at an end portion; and

a second tubular member coupled to another end of the tubular sleeve comprising external threads at an end portion that engage the internal threads of the end portion of the first tubular member.

138. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole;

a second casing string within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the first and second casing strings are radially expanded and plastically deformed within the borehole;

wherein the inside diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an internal flange positioned between the ends of the

tubular sleeve;

a first tubular member received within an end of the tubular sleeve in abutment with the internal flange that comprises internal threads;

a second tubular member received within another end of the tubular sleeve in abutment with the internal flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential tension;

wherein the first tubular member is in circumferential compression;

wherein the second tubular member is in circumferential compression;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second tubular members.

141. An apparatus for extracting geothermal energy from a subterranean source of geothermal energy, comprising:

a borehole that traverses the subterranean source of geothermal energy;

a first casing string positioned within the borehole; and

a second casing string positioned within the borehole that traverses the subterranean source of geothermal energy that overlaps with the first casing string;

wherein the interior diameter of a passage defined by the first and second casing strings is constant; and

wherein at least one of the first and second casing strings comprise:

a tubular sleeve comprising an external flange positioned between the ends of the tubular sleeve;

a first tubular member that receives an end of the tubular sleeve that abuts external flange that comprises internal threads;

a second tubular member that receives another end of the tubular sleeve that abuts the external flange that comprises external threads that engage the internal threads of the first tubular member;

wherein the tubular sleeve is in circumferential compression;

wherein the first tubular member is in circumferential tension;

wherein the second tubular member is in circumferential tension;

wherein a fluid tight seal is provided between the tubular sleeve and at least one of the first and second tubular members; and

wherein a fluid tight seal is provided between the threads of the first and second